Heat Rejection for Trough Rankine Cycles

Parabolic Trough Review Meeting
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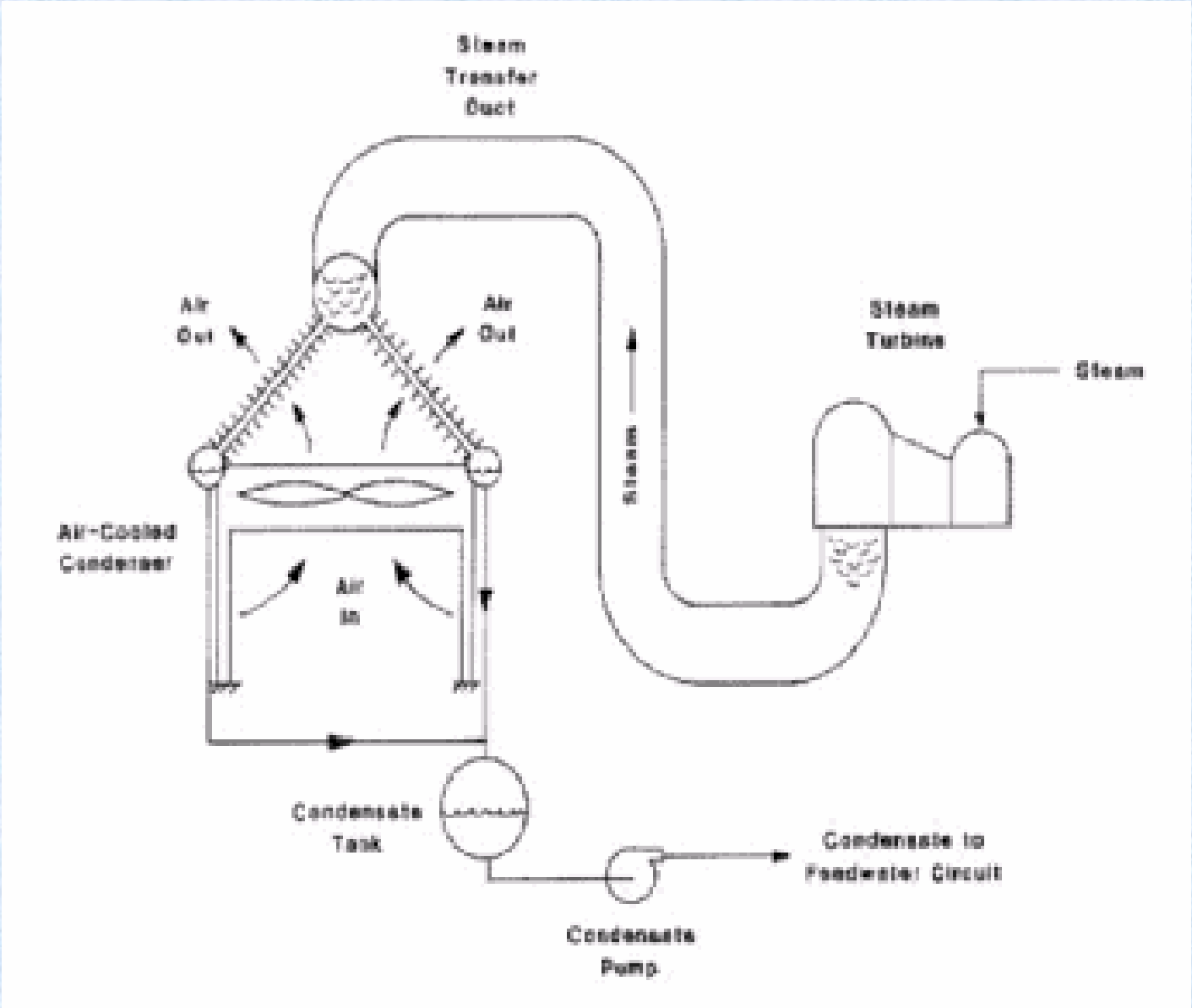
Study Basis

- 88 MWe parabolic trough project, without thermal storage
- GateCycle Rankine cycle model
- Excelergy default performance and cost models, except for heat rejection systems
- Barstow weather data; 30 year average

Air Cooled Condenser



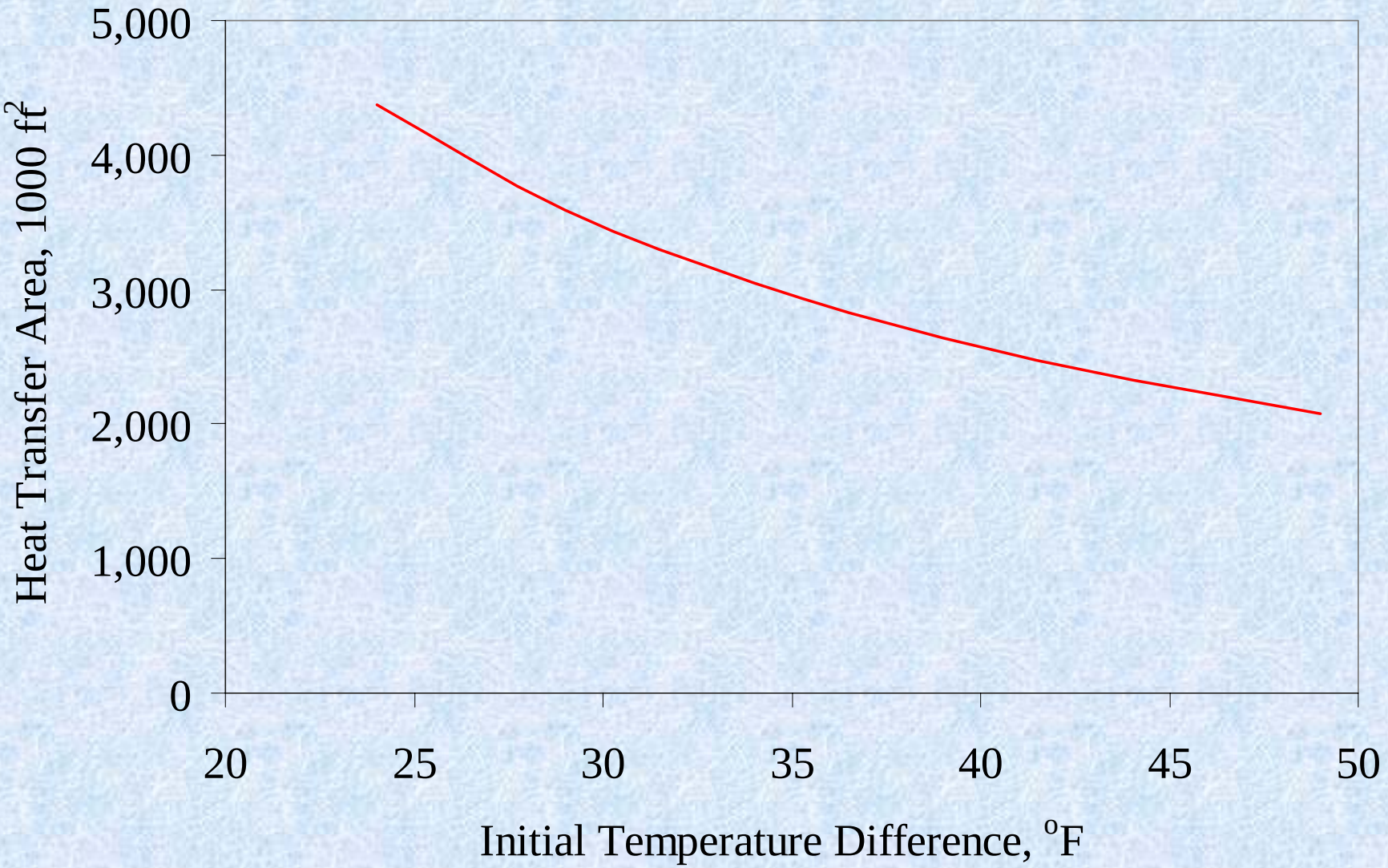
Thermodynamic Boundaries

- Carnot efficiency: $1 - \frac{T_{reject}}{T_{source}}$

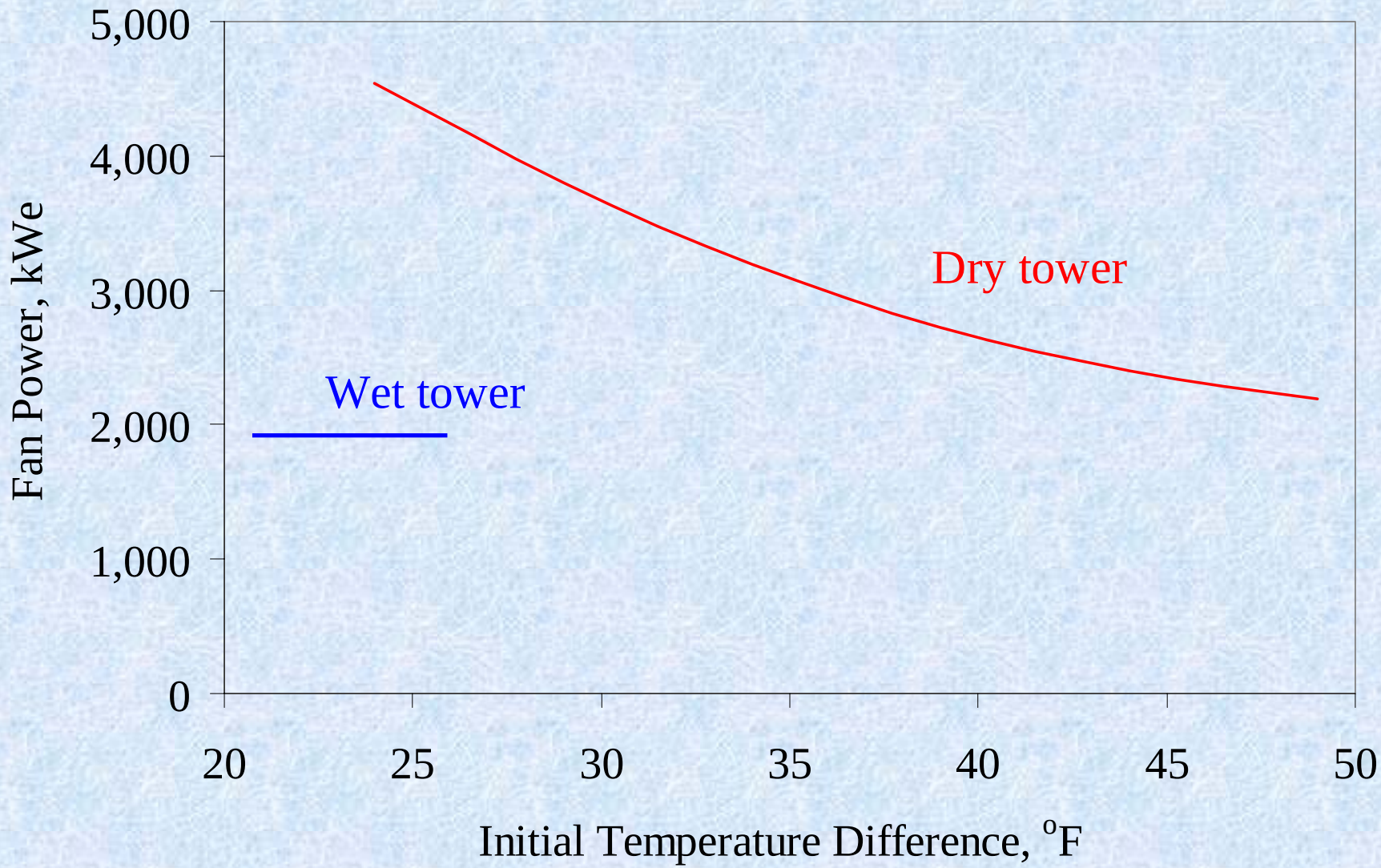
- With 700 ^{o}F source temperature at desert site:

$$\frac{Carnot_{104\,^{o}F}}{Carnot_{68\,^{o}F}} = 0.94$$

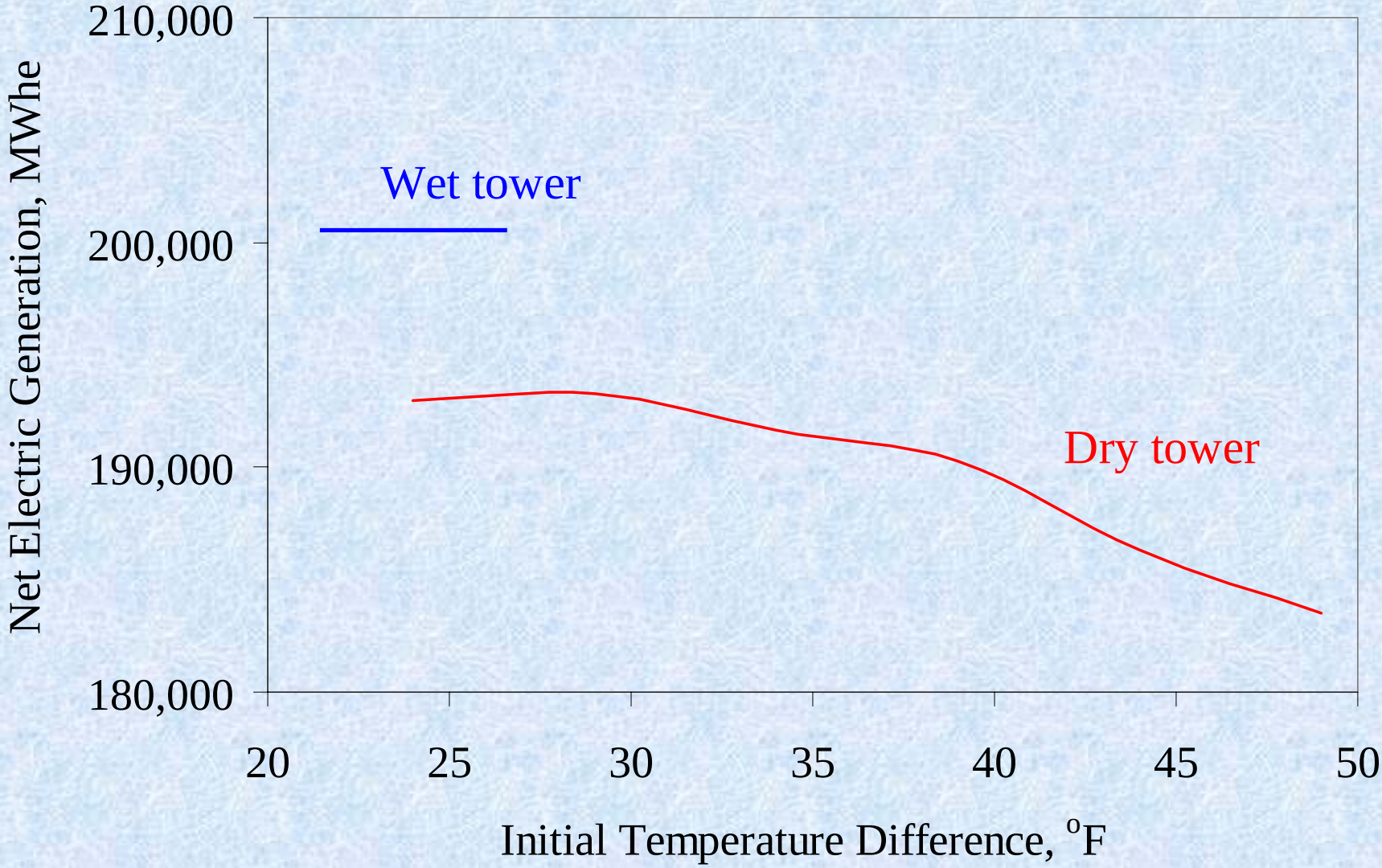
Air Cooled Condenser Surface Area



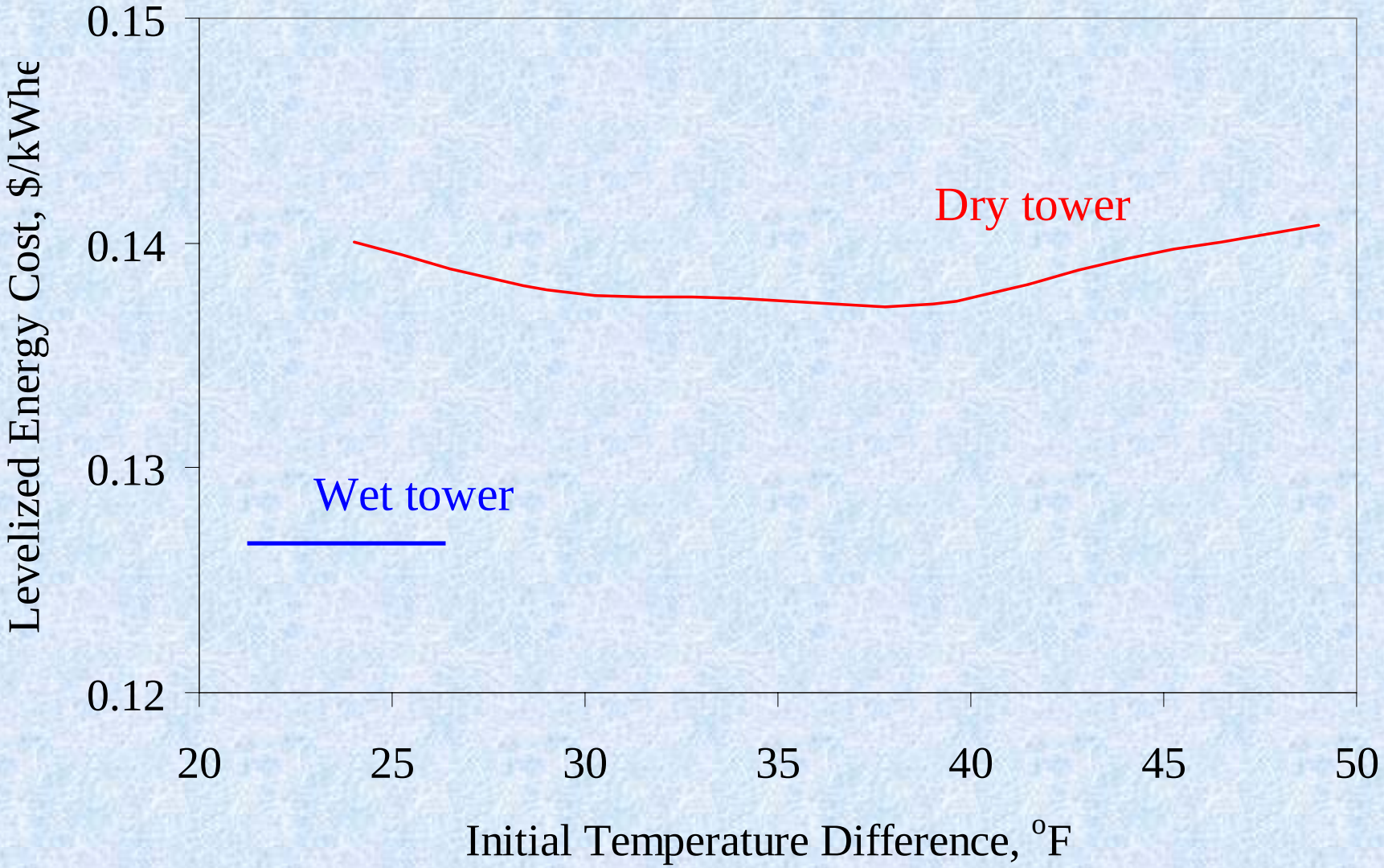
Cooling Tower Fan Power



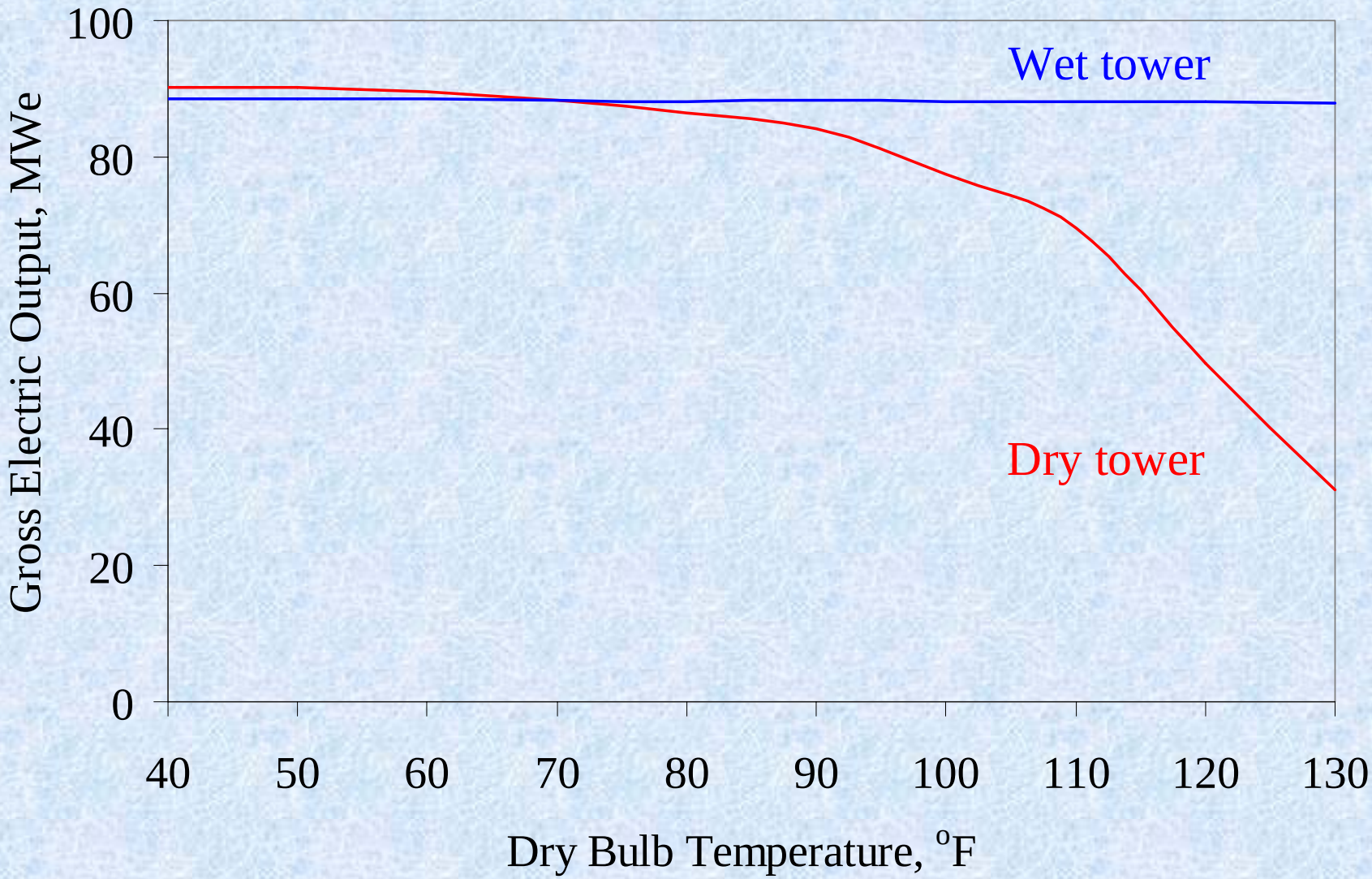
Net Electric Generation



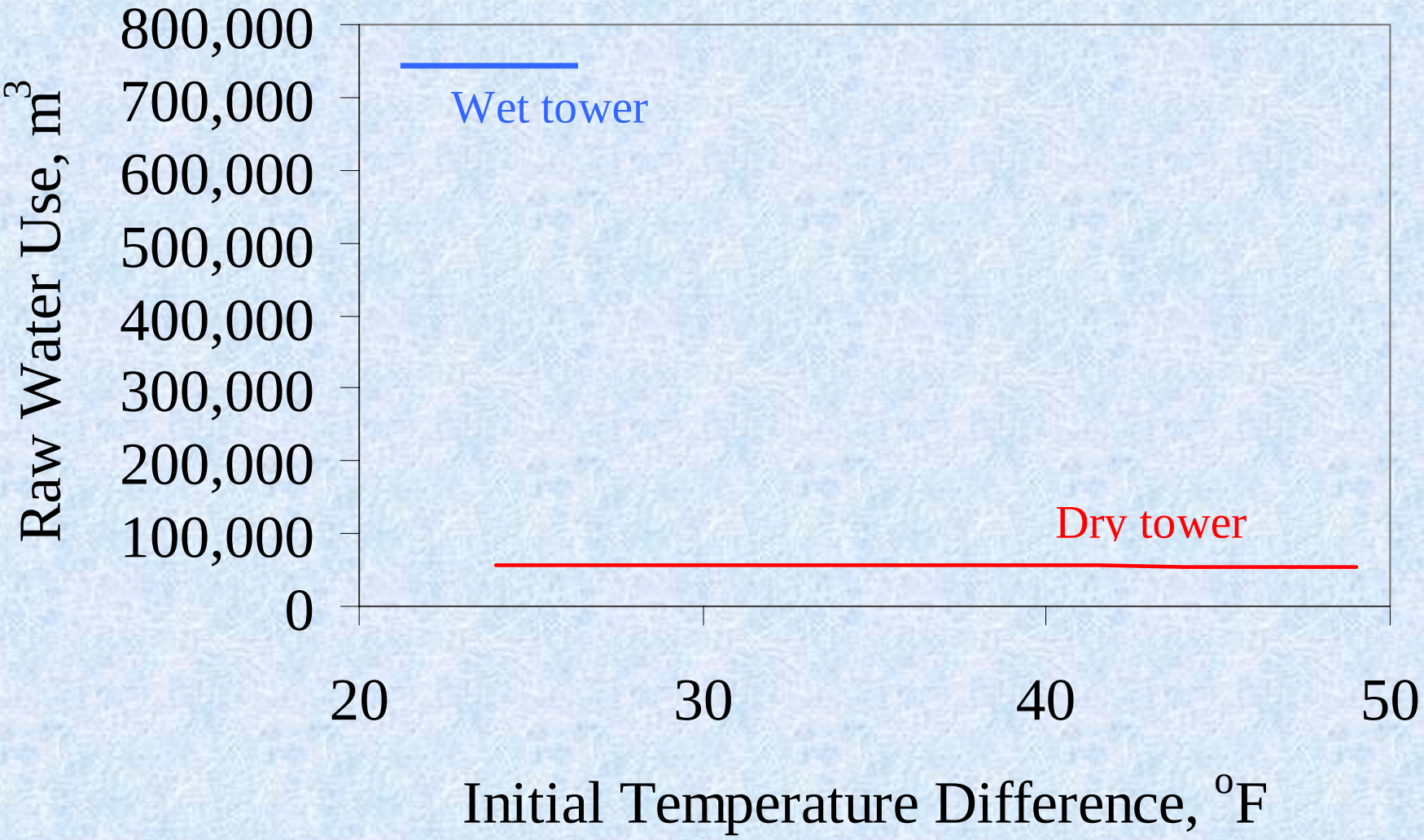
Levelized Energy Costs



Gross Plant Output
8 in. HgA Condenser Pressure Limit



Annual Water Demand



Conclusions

- Dry heat rejection imposes a 7 to 9 percent penalty on the levelized energy cost
- Raw water costs need to increase by about 10 for economic parity
- Solar thermal energy is expensive, but small cooling tower approach temperatures cannot be justified due to limited annual operating hours at dry bulb temperatures above 100 ^{o}F.